

# **The Potential for Natural Source Zone Depletion of Petroleum Hydrocarbons in Tropical Environments**

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**Background/Objectives.** Natural source zone depletion (NSZD) of petroleum hydrocarbons, especially at sites with light non-aqueous phase liquid (LNAPL), is gaining significant interest in North America. Research and case studies are now available demonstrating that NSZD processes are almost always occurring at LNAPL sites and rates of NSZD can be significant, especially compared to some older, active remediation systems. As a consequence, best practices are evolving to include NSZD as a component of the LNAPL conceptual site model (CSM), and consideration of NSZD as a component of management of most LNAPL sites.

LNAPL sites exist in many Southeast Asia countries, especially in urban areas. The CSMs of these sites are similar to those of sites in North America, except that the tropical environment in Southeast Asia results in much higher precipitation and elevated subsurface temperatures. The implications of these environmental differences on NSZD rates in tropical environments have not been fully evaluated or appreciated.

**Approach/Activities.** Site-specific NSZD rate data for sites in tropical environments are limited. Soil gas data are available from one tropical sites and can be used to make some useful general conclusions on the NSZD processes. In addition, NSZD field rate data from other parts of the world, that include soil temperature, were gathered and evaluated. A standard, Arrhenius type of equation was used to extrapolate this data to the warmer temperatures that are present in the tropical sites. The recently developed BioTherm model was also used to extrapolate and evaluate the effects of elevated temperatures on NSZD. BioTherm is a finite difference model for heat transport in soils, with internal heat generation rates due to heat produced from NSZD reactions. BioTherm estimates local soil biodegradation rates based on local soil temperatures and contaminant concentrations, informed by literature biodegradation rates.

**Results/Lessons Learned.** The results of this study suggest that rates of NSZD should be significant in the tropical temperatures present in Southeast Asia, likely exceeding (on average) those in temperate climates. As a consequence, the best practice evolution for LNAPL sites applies equally (if not more) to Southeast Asia. NSZD should be incorporated into the CSM and included as a component for LNAPL management at these sites.